
The many shapes of a knitted fabric at rest

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Abstract

Textiles consist not only of our daily clothes, but also act as reinforcement for composite materials, or soil consolidators, and found a renewed interest in emerging fields such as soft robotics. For all these applications, their mechanical properties are crucial aspects, but predictive models of textiles remain incredibly challenging to construct owing to their complex intertwined thread structures.

Knitted fabrics are textiles composed of a periodic array of looped and intertwined threads. A knit can then be viewed as a structure made of multiple slender elements interacting via frictional contacts. For such structures, even basic mechanical properties such as the rest state of the object, or its natural shape without external forces, are not obvious nor unique.

We used a combination of experiments, numerical simulation, and analytical calculations to predict and understand the natural shapes of knitted fabrics from three basic ingredients: yarn elasticity, loop geometry, and frictional contacts between the yarns. From laboratory experiments and numerical simulations, we determined that the possible natural shapes of a model Jersey knit span a continuous set of possible aspect ratios bounded by a maximum height. From a theoretical description inspired by knot mechanics, we find that geometrical constraints and yarn elasticity control the set of accessible aspect ratios, while inter-yarn friction sets the maximum height.

Reference:

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